

POLYBROMINATED BIPHENYLS* (PBBs)
First Listed in the *Fourth Annual Report on Carcinogens*

CARCINOGENICITY

A commercial mixture of polybrominated biphenyls is *reasonably anticipated to be a human carcinogen* based on sufficient evidence of carcinogenicity in experimental animals (NTP 1983, IARC 1978, 1986). When administered by oral gavage, technical grade hexabromobiphenyl (FireMaster FF-1[®], CAS No. 67774-32-7) induced hepatocellular carcinomas in mice and rats of both sexes and cholangiocarcinomas and neoplastic nodules of the liver in rats of both sexes (NTP 1983). When administered by gastric intubation, FireMaster FF-1[®] induced trabecular hepatocellular carcinomas and neoplastic nodules of the liver in female rats. Exposure of female rats to FireMaster FF-1[®] by oral administration induced trabecular hepatocellular carcinomas in the offspring of both sexes (IARC 1986).

No adequate human studies of the relationship between exposure to polybrominated biphenyls and human cancer have been reported (IARC 1986).

PROPERTIES

Polybrominated biphenyls with three or more bromine atoms are solids with low volatility; this volatility decreases with increasing bromine numbers. Polybrominated biphenyls are virtually insoluble in water, soluble in fat, and slightly to highly soluble in various organic solvents; their solubility decreases with increasing bromine number. These compounds are relatively stable and chemically unreactive, although several of the common isomers reportedly photodegrade with reductive debromination upon exposure to ultraviolet light. The quantity of hexabromobiphenyl in commercial products ranged from 60% to 70% with up to 22 different biphenyl isomers present (IARC 1978).

USE

Polybrominated biphenyls were used as flame retardant additives in synthetic fibers and molded plastics. Manufacturers of polycarbonates, polyesters, polyolefins, and polystyrenes have used polybrominated biphenyls. Although polybrominated biphenyls are not currently used in consumer products, the Consumer Product Safety Commission (CPSC) reported that hexabromobiphenyl was the primary component in the most widely used mixture of polybrominated biphenyls (IARC 1986).

PRODUCTION

Polybrominated biphenyls are no longer produced in commercial quantities in the United States. Although all of the technical grades contained a number of brominated isomers, polybrominated biphenyls were formerly produced in three primary forms: hexabromobiphenyl (CAS No. 36355-01-8), octabromobiphenyl (CAS No. 61288-13-9), and decabromobiphenyl

* No separate CAS registry number is assigned to polybrominated biphenyls.

(CAS No. 13654-09-6). The sole U.S. producer of hexabromobiphenyl ceased production in November 1974 because of a 1973 incident in which the chemical was mistaken for a nutrient additive and 2,000 lb was added to animal feed, thereby resulting in the destruction of thousands of farm animals. Production of hexabromobiphenyl in 1974 was approximately 4.9 million lb. This volume had increased steadily from the 21,000 lb produced in 1970 when production began. From 1970 to 1974, approximately 11 million lb of hexabromobiphenyl were produced under the trade names FireMaster BP-6[®] and FireMaster FF-1[®]. One U.S. firm produced octabromobiphenyl and decabromobiphenyl from 1970 to 1979 and another U.S. firm produced decabromobiphenyl from 1973 to sometime prior to 1977. Approximately 807,000 lb of these chemicals were produced in 1976, all of which were exported. Estimated U.S. production in 1975 was approximately 170,000 lb. Production increased steadily from 1970 when 31,000 lb of octabromobiphenyl and decabromobiphenyl were produced (IARC 1986).

EXPOSURE

The primary routes of potential human exposure to polybrominated biphenyls are ingestion, inhalation, and dermal contact. Residues remaining in and around plants that formerly manufactured, processed, or produced products using polybrominated biphenyls are the current sources for exposure. The National Occupational Hazard Survey, conducted by NIOSH from 1972 to 1974, estimated that 4,900 workers were possibly exposed to polybrominated biphenyls in the workplace. Workers in one company that manufactured polybrominated biphenyls were possibly exposed to polybrominated biphenyls by skin contact, inhalation, and unintentional ingestion; investigators detected 1.1 to 1,729 ppb of hexabromobiphenyl in the workers' sera and 0.51 to 581 ppm in their adipose tissue (NIOSH 1976).

In 1973, when polybrominated biphenyls were inadvertently mixed into livestock feed in Michigan, thousands of animals died or were destroyed. In 1973 and 1974, 8,000 to 12,500 Michigan residents were exposed to meat, milk, butter, cheese, and eggs contaminated with polybrominated biphenyls. A general population survey conducted in Michigan at a later date revealed that only 10% of the population did not have detectable levels of polybrominated biphenyls in their blood (IARC 1978). In 1976, 524 dairy farmers had a median concentration of 2.6 µg/L polybrominated biphenyls in serum. An independent study conducted from 1976 to 1977 in Michigan on 3,639 subjects (mainly farm residents and chemical workers) showed a median value of 3.0 µg/L in serum. Another 1977 study of 3,683 Michigan residents showed concentrations ranging from <1 to 3,150 µg/L with a geometric mean of 4.1 µg PBBs/L. Significant body burdens could persist throughout the lifetime of exposed individuals because polybrominated biphenyls are biologically stable and eliminated slowly (IARC 1986). Additional exposure information may be found in the ATSDR Toxicological Profile for Polybrominated Biphenyls (ATSDR 1995).

REGULATIONS

EPA regulates polybrominated biphenyls under the Toxic Substances Control Act (TSCA) and regulates technical-grade hexabromobiphenyl under the Superfund Amendments and Reauthorization Act (SARA). A broad category of polybrominated biphenyls potentially containing up to some 200 to 300 individual chemicals is subject to a special TSCA reporting rule. The technical grade of hexabromobiphenyl, FireMaster BP-6[®], is subject to reporting requirements under SARA. EPA has proposed handling and reporting and record-keeping requirements for polybrominated biphenyls under the Resource Conservation and Recovery Act (RCRA).

Under the Food, Drug, and Cosmetic Act (FD&CA), FDA regulates polybrominated biphenyls as unavoidable environmental contaminants. In cooperation with the Centers for Disease Control (CDC) and the Public Health Department of the State of Michigan, FDA monitors the long-term human health effects from acute exposure to polybrominated biphenyls.

OSHA regulates polybrominated biphenyls under the Hazard Communication Standard and as chemical hazards in laboratories. Regulations are summarized in Volume II, Table 148.

REFERENCES

ATSDR. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Polybrominated Biphenyls. (Final Report). Atlanta, GA: ATSDR, Public Health Service, U.S. Department of Health and Human Services. 1995. 274 pp. NTIS Accession No. PB95-264388.

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